

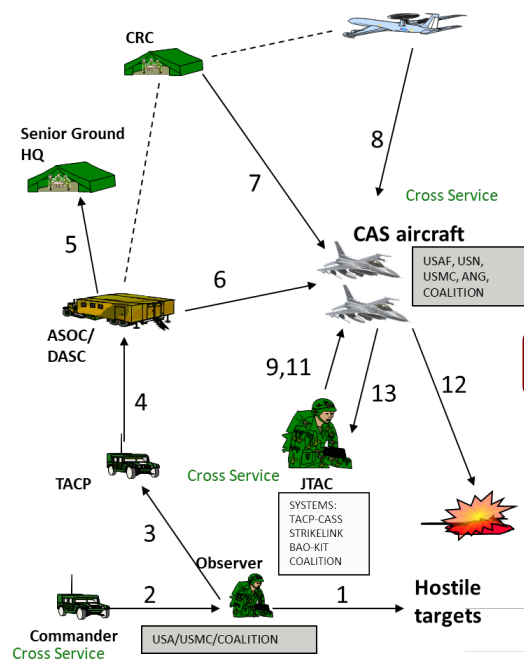
**Research Task / Overview**

A persistent challenge for acquisition stakeholders is a method to value technology alternatives against mission impact that meaningfully informs decision-making for the purpose of relating value and cost.

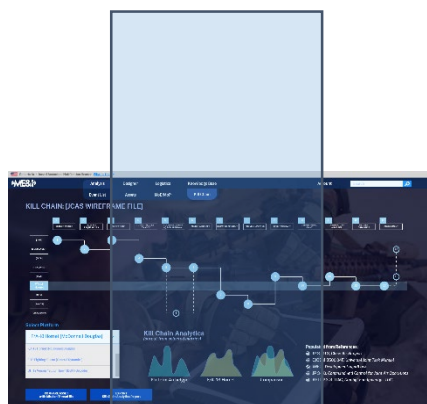
- Expected value of information theory provides a well-established basis for valuing various forms of information within a decision-theoretic framework
- Our approach is to apply this theory as a basis to value technology alternatives for well-specified mission impacts
- Then demonstrate feasibility by analysis comparing two model-informed alternatives of varying fidelity

**Data & Analysis**

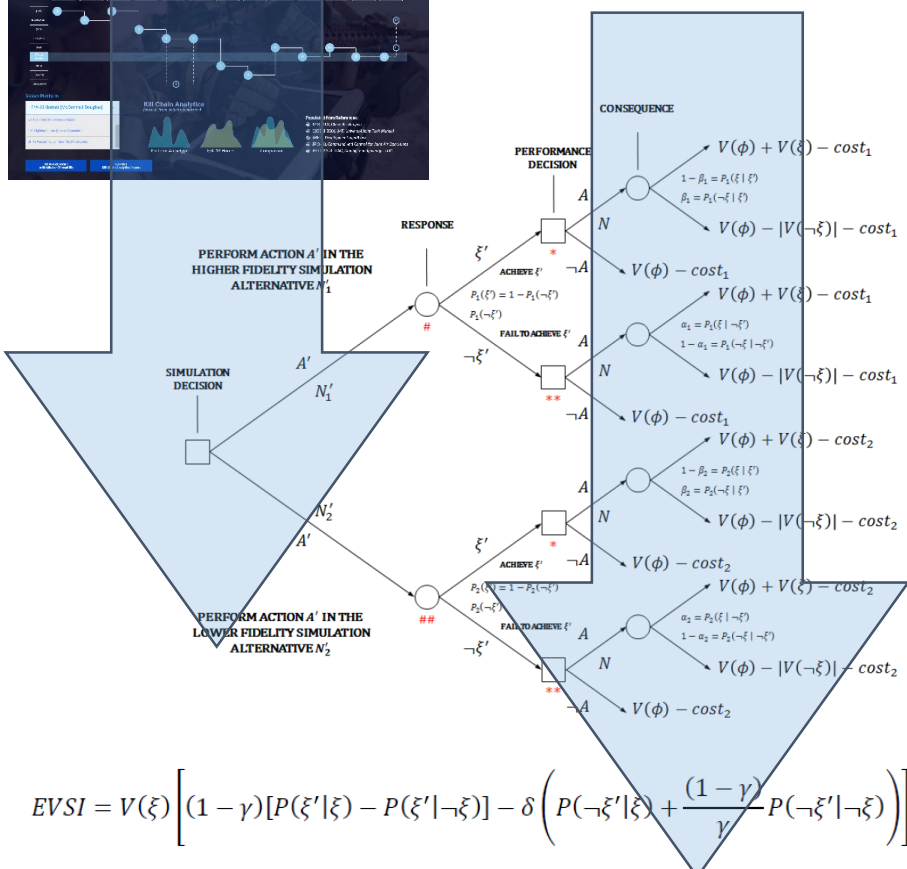
Mission Event No.	Description
1	Unit detects target
2	Commander decides to request CAS
3	Unit notified TACP
4	TACP passes request to ASOC < 5 min
5	ASOC coordinates with senior ground HQs which approve request
6	ASOC assigns on-call aircraft
7	CRC send aircraft to contact point (CP)
8	AWACS passes critical updates to aircraft > 95% Accrty
9	JTAC briefs aircraft < 3 min
10	Aircraft depart initial point (IP)
11	JTAC controls CAS aircraft
12	Bombs on target > 98.9% PK
13	Assessment



**KILL CHAIN ANALYTICS**



**EVSI-BASED SCORING**



$$EVSI = V(\xi) \left[ (1 - \gamma) [P(\xi'|\xi) - P(\xi'|\neg\xi)] - \delta \left( P(\neg\xi'|\xi) + \frac{(1 - \gamma)}{\gamma} P(\neg\xi'|\neg\xi) \right) \right]$$



**Goals & Objectives**

Our objective for this effort is to demonstrate an effective, i.e. algorithmic, method to value model-informed alternatives for well-specified objectives. If successful, this approach will establish expected value of information theory as a basis to **quantify the model-informed trade-space** between cost of technology alternatives and mission effectiveness. We envision this approach as the basis for an enabling technology to **optimize modeling decisions within this trade-space**. A successful research outcome will:

- Provide a rigorous mathematical basis for design of experiments for testing model-based alternatives
- Demonstrate the use of expert opinion as initial evidence via the Bayesian priors
- Formalize growing confidence in model-informed results, even when initial probabilities are difficult to quantify
- Develop techniques to quantify the value of mission effectiveness using familiar financial metrics such as Expected Value of Sample Information and Return on Investment.

**Methodology**

The proposed solution applies Bayesian statistical inference to an Expected Value of Sample Information decision structure to iteratively exploit simulation or model-based test data in a mathematically rigorous and defensible way. The method builds upon an existing framework for valuing simulation alternatives for training systems based on use. Develop mathematical analyses, walk-through examples, demonstrations, or empirical analyses to demonstrate the feasibility or limitations of the following elements of the technical solution:

- Value specific performance-based outcomes
- Estimate probabilities using Bayesian analysis
- Initialize using subjective prior probabilities
- Differentiate the value of model-informed alternatives of varying fidelity using expected value or expected utility

**Future Research**

Develop a software component that calculates EVSI-based score for technology alternatives in a Mission Engineering and Integration Framework:

- Specification tools for missions and mission threads
- Adaptive data engineering and scenario generation
- Persistent data collection from simulation analytics
- Integrated scoring component in Mission Engineering and Integration analytics environment

**Contacts/References**

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